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## **Review on available Information on Flora, Fauna and Environment (DanWEC Vaekstforum 2011)**

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**Review on available information on  
flora, fauna and  
environment  
(DanWEC Vaekstforum 2011)**

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**DCE Technical Report No. 143**

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(DanWEC Vaekstforum 2011)**

by

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March 2012

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## Preface

The Danish Wave Energy Centre (DanWEC) has been established in 2009 because of participated desire to market the trial wave energy projects which are already in Hanstholm and others to come. The DanWEC is a part of Hanstholm harbour in the North-West of Denmark.

The Center will contribute at creating a local base for knowledge, education and possibly a workplace which will be leased out to trial projects. It is therefore likely that different developers will deploy their wave energy devices during the next years in this location and therefore detailed knowledge on a number of environmental and physical parameter is necessary.

The present report has been prepared by Lucia Margheritini ([lm@civil.aau.dk](mailto:lm@civil.aau.dk)). Morten Lauge Pedersen ([mlp@civil.aau.dk](mailto:mlp@civil.aau.dk)) is responsible for the data fetching and review; Arianna Azzellino ([ara@civil.aau.dk](mailto:ara@civil.aau.dk)) is responsible for preliminary data analysis. The report should function as a review and assessment of the existing documents and present knowledge on information at the DanWEC location.

The present report has been prepared under the project No. 834101 “DanWEC Vaekstforum 2011”, task 4: “Collection and presentation of basic data on flora and fauna for the DanWEC site at the Port of Hanstholm”.

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## Introduction

Marine Environmental Data are collected as a part of the routine monitoring programme of the marine environment. The programme includes a physical / chemical component and a biological programme. The biological and the physical / chemical parameters are not necessarily sampled at the same stations (Fig. 1). The monitoring data are historical and covers a 20 year span from app. 1987 to 2007. Newer data are probably available but we need to contact local environmental offices to get access to data.

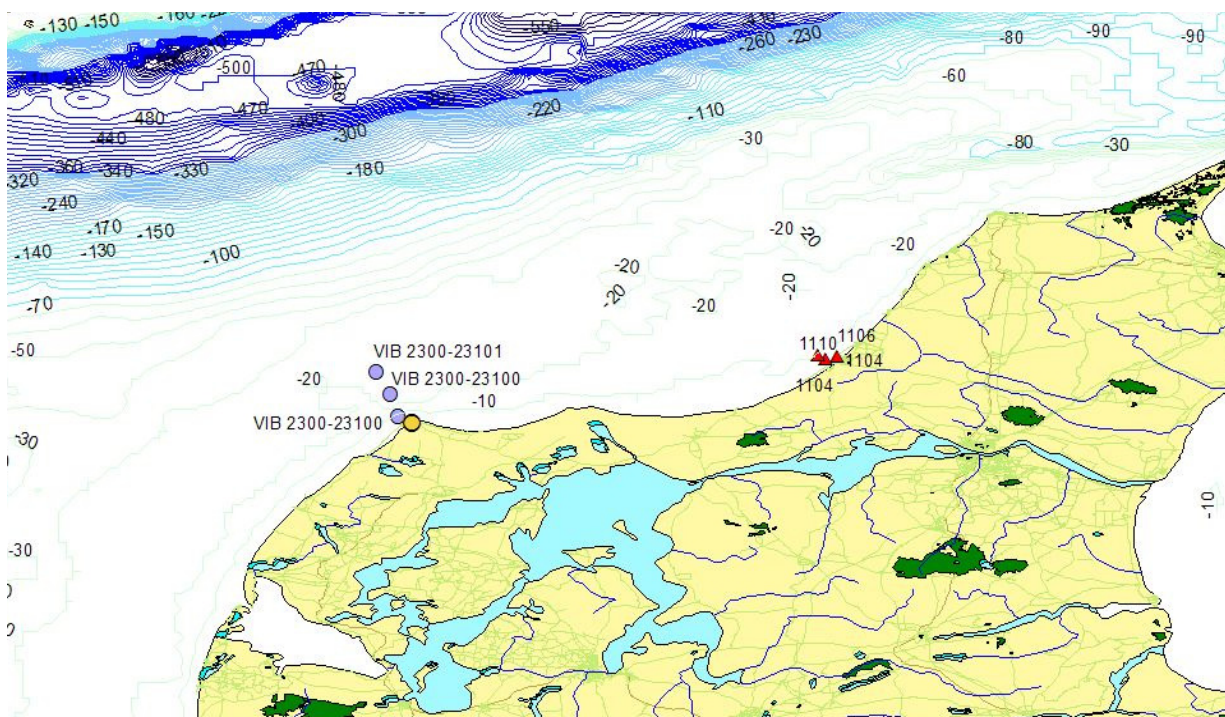


Figure 1. Map of North-Jutland with highlighted data stations of relevance of the DanWEC and Hanstholm.

### • Physical / chemical programme

Four are the stations of interest for the Danwec (Table 1). All parameters are sampled in different depths: Top /5-10m/10-15m/15-20m/20-25m (Table 2). All data is available for online database <http://www.miljoportal.dk/Overfladevand/> (Fig 2).

Table 1. Relevant stations for acquisition of marine physical and chemical Environmental Data at Hanstholm.

Station	Name	Position	
VIB 2300-23100	1 NM NNW of Hanstholm	8° 35,3' E	57° 08' N
VIB 2300-23101	4 NM NNW of Hanstholm	8° 34' E	57° 11' N
VIB 2300-23102	7 NM NNW of Hanstholm	8° 32' E	57° 14' N
VIB1100-00002	Hanstholm/Thyborøn (Nørre Vorupør)		



Table 2. Physical and Chemical parameters available at the stations.

Parameters	
Physical	Chemical
Depth	pH
Wave height	Suspended sediment
Air temperature	TOC
Air pressure	NH <sub>4</sub> -N
Wind speed	NO <sub>23</sub> -N
Wind direction	Tot-N
Density	PO <sub>4</sub> -P
Salinity	Tot-P
Oxygen	Chloride
Temperature	Silicon
Fluorescence	Chlorophyl

Table 3. Station, period and number of samples (physical and chemical parameters).

Samples		
Station	Sampling period	Number of samples
VIB 2300-23100	1989 – 2009	162 – 219
VIB 2300-23101	1989 – 1997	104
VIB 2300-23102	1989 – 1997	104
VIB1100-00002	-	-

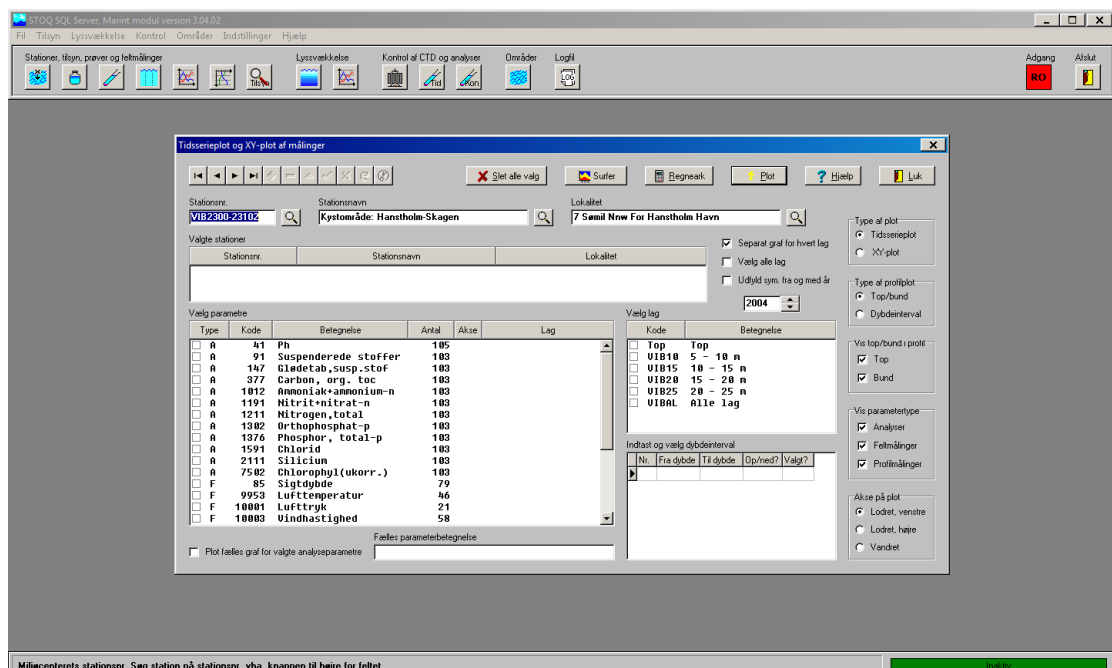


Figure 2. Screen dump from the online database of physical / chemical parameters

- **Biological programme**

The biological parameters are: taxonomic composition and abundance of marine bed invertebrates. Samples are standardized grab samples of equal size. All data is available for online database (Fig 3). <http://www.miljoportal.dk/Overfladevand/>

**Table 4. Relevant stations for acquisition of marine biological Environmental Data at Hanstholm.**

Station	Name	Position	
1104	Jammerbugt 1	9° 34,16' E	57° 15,73' N
1106	Jammerbugt 2	9° 35,59' E	57° 16,02' N
1110	Jammerbugt 3	9° 33,05' E	57° 16,30' N

**Table 5. Station, period and number of samples (biological parameters).**

Samples		
Station	Sampling period	Number of samples
1104	1989 – 1996	12
1106	1989 – 1996	12
1110	1989 – 1996	12

The screenshot displays a web-based data entry and search interface. At the top, there are navigation tabs and a search bar. Below this, a form allows users to filter data by Station (1104), Date (30-04-1997), and various parameters like Depth, Volume, and Temperature. A table of results is shown below the form, listing species names and their associated measurements. The table is organized into columns for Station, Date, Species, and various measurements. The results show a list of species and their corresponding measurements.

Station	Date	Species	Measurements
1104	30-04-1997	1100000	...
1104	30-04-1997	1100001	...
1104	30-04-1997	1100002	...
1104	30-04-1997	1100003	...
1104	30-04-1997	1100004	...
1104	30-04-1997	1100005	...
1104	30-04-1997	1100006	...
1104	30-04-1997	1100007	...
1104	30-04-1997	1100008	...
1104	30-04-1997	1100009	...
1104	30-04-1997	1100010	...
1104	30-04-1997	1100011	...
1104	30-04-1997	1100012	...
1104	30-04-1997	1100013	...
1104	30-04-1997	1100014	...
1104	30-04-1997	1100015	...
1104	30-04-1997	1100016	...
1104	30-04-1997	1100017	...
1104	30-04-1997	1100018	...
1104	30-04-1997	1100019	...
1104	30-04-1997	1100020	...
1104	30-04-1997	1100021	...
1104	30-04-1997	1100022	...
1104	30-04-1997	1100023	...
1104	30-04-1997	1100024	...
1104	30-04-1997	1100025	...
1104	30-04-1997	1100026	...
1104	30-04-1997	1100027	...
1104	30-04-1997	1100028	...
1104	30-04-1997	1100029	...
1104	30-04-1997	1100030	...
1104	30-04-1997	1100031	...
1104	30-04-1997	1100032	...
1104	30-04-1997	1100033	...
1104	30-04-1997	1100034	...
1104	30-04-1997	1100035	...
1104	30-04-1997	1100036	...
1104	30-04-1997	1100037	...
1104	30-04-1997	1100038	...
1104	30-04-1997	1100039	...
1104	30-04-1997	1100040	...
1104	30-04-1997	1100041	...
1104	30-04-1997	1100042	...
1104	30-04-1997	1100043	...
1104	30-04-1997	1100044	...
1104	30-04-1997	1100045	...
1104	30-04-1997	1100046	...
1104	30-04-1997	1100047	...
1104	30-04-1997	1100048	...
1104	30-04-1997	1100049	...
1104	30-04-1997	1100050	...
1104	30-04-1997	1100051	...
1104	30-04-1997	1100052	...
1104	30-04-1997	1100053	...
1104	30-04-1997	1100054	...
1104	30-04-1997	1100055	...
1104	30-04-1997	1100056	...
1104	30-04-1997	1100057	...
1104	30-04-1997	1100058	...
1104	30-04-1997	1100059	...
1104	30-04-1997	1100060	...
1104	30-04-1997	1100061	...
1104	30-04-1997	1100062	...
1104	30-04-1997	1100063	...
1104	30-04-1997	1100064	...
1104	30-04-1997	1100065	...
1104	30-04-1997	1100066	...
1104	30-04-1997	1100067	...
1104	30-04-1997	1100068	...
1104	30-04-1997	1100069	...
1104	30-04-1997	1100070	...
1104	30-04-1997	1100071	...
1104	30-04-1997	1100072	...
1104	30-04-1997	1100073	...
1104	30-04-1997	1100074	...
1104	30-04-1997	1100075	...
1104	30-04-1997	1100076	...
1104	30-04-1997	1100077	...
1104	30-04-1997	1100078	...
1104	30-04-1997	1100079	...
1104	30-04-1997	1100080	...
1104	30-04-1997	1100081	...
1104	30-04-1997	1100082	...
1104	30-04-1997	1100083	...
1104	30-04-1997	1100084	...
1104	30-04-1997	1100085	...
1104	30-04-1997	1100086	...
1104	30-04-1997	1100087	...
1104	30-04-1997	1100088	...
1104	30-04-1997	1100089	...
1104	30-04-1997	1100090	...
1104	30-04-1997	1100091	...
1104	30-04-1997	1100092	...
1104	30-04-1997	1100093	...
1104	30-04-1997	1100094	...
1104	30-04-1997	1100095	...
1104	30-04-1997	1100096	...
1104	30-04-1997	1100097	...
1104	30-04-1997	1100098	...
1104	30-04-1997	1100099	...
1104	30-04-1997	1100100	...

**Figure 3. Screen dump from the online database of biological parameters**

## Biological programme

In this report only the available information about benthos community will be analysed.

### Preliminary exploration of the abundance data.

Different different kinds of benthos abundance data are available (biomass1: wet weight; biomass2: dry weight, and biomass3: ashes) but they are strongly correlated (see the correlation matrix shown in Table 6) so all the following analysis concern the Biomasse vådvægt). Due to the strongly asymmetrical distribution of the biomass values a logarithmic transformation (e.g. Log10) was applied obtaining a much more symmetrical distribution which was further splitted by year and by month (Fig. 4).

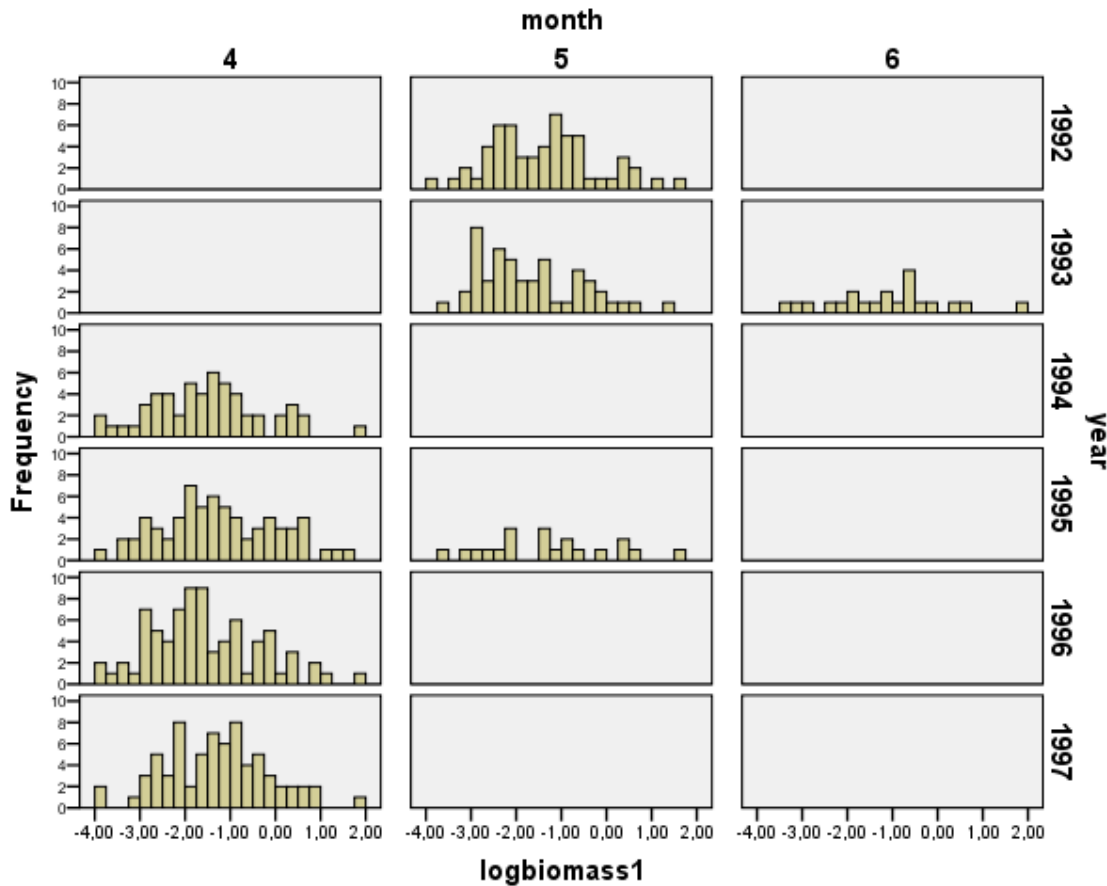


Figure 4. Frequency distribution of logbiomass 1 by year (rows) and by month (columns). The presence of empty crosstabulations is due to missing data.

Afterwards, by means of a One-Way ANOVA (Rutherford, 2001), the hypothesis that the biomass varies yearly or monthly was tested. ANOVA showed clearly that the biomass values did not significantly change by year or month in the used dataset (Tables 7, 8). Moreover, it was also tested whether the three sampled stations (i.e. 1104, 1106 and 1110) were homogenous in terms of biomass. In this case One-Way ANOVA showed significant differences (Table 9).

**Table 6. Matrix of the Pearson's correlation coefficients (available (biomass1: wet weight; biomass2: dry weight, and biomass3: ashes). The significance level (i.e. Sig.) and number of cases (i.e. N) are also shown. The correlation coefficients highly significant (Sig.<0.01) are labeled with the "\*\*\*" symbol.**

Correlations				
		biomass1	biomass2	biomass3
biomass1	Pearson correlation	1	,994**	,995**
	Sig. (2-tails)		,000	,000
	N	420	420	420
biomass2	Pearson correlation	,994**	1	,996**
	Sig. (2-tails)	,000		,000
	N	420	592	592
biomass3	Pearson correlation	,995**	,996**	1
	Sig. (2-tails)	,000	,000	
	N	420	592	592

**Table 7. One.-way ANOVA results: the logbiomass1 was tested against the year. All the ANOVA statistics are shown (i.e. Sum of the Squares, Mean of the Squares, Fisher-Snedecor F and the Significance level (Sig.). No statistical difference was assessed.**

One-Way ANOVA (Fixed Factor: Year)					
logbiomass1					
	Sum of the Squares	df	Mean of the Squares	F	Sig.
Between	6.788	5	1.358	.921	.467
Within	610.129	414	1.474		
Totale	616.917	419			

**Table 8. One.-way ANOVA results: the logbiomass1 was tested against the month. All the ANOVA statistics are shown (i.e. Sum of the Squares, Mean of the Squares, Fisher-Snedecor F and the Significance level (Sig.). No statistical difference was assessed.**

One-Way ANOVA (Fixed Factor: Month)					
logbiomass1					
	Sum of the Squares	df	Mean of the Squares	F	Sig.
Between	2.560	2	1.280	.869	.420
Within	614.358	417	1.473		
Totale	616.917	419			

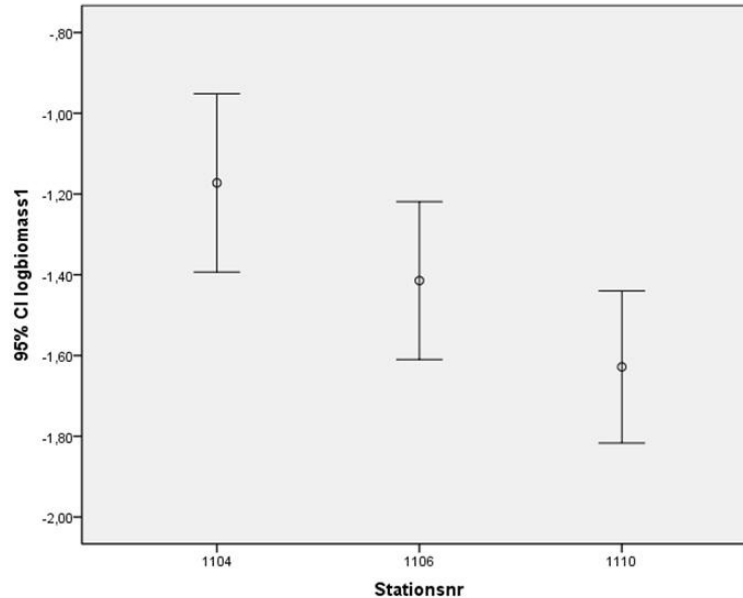
**Table 9 One.-way ANOVA results: the logbiomass1 was tested across the sampling stations. All the ANOVA statistics are shown (i.e. Sum of the Squares, Mean of the Squares, Fisher-Snedecor F and the Significance level (Sig.). A statistical difference was assessed.**

One-Way ANOVA (Fixed Factor: Stations)					
logbiomass1					
	Sum of the Squares	Df	Mean of the Squares	F	Sig.
Between	13.351	2	6.676	4.612	.010
Within	603.566	417	1.447		
Totale	616.917	419			

A following Tukey test for multiple comparisons (Tukey, 1949) showed that station 1110 has a biomass significantly lower (depth: -10 m) than station 1104 (which is the station closer to the shore). While station 1106 (depth: -7 m) is somewhat intermediate between these two and is not significantly different from these (Table 10).

**Table 10 Tukey Multiple comparison test. The three stations are compared pairwise. The Significance levels are shown. A significant difference was found between station 1110 and 1104 (in blue).**

Multiple comparisons			
dependent: logbiomass1			
Test: Tukey HSD (Sig. Are shown)			
(I) Stationsnr	(J) Stationsnr		
	1104	1106	1110
1104		,222	<b>,007</b>
1106	,222		,273
1110	<b>,007</b>	,273	



**Figure 5 95% Confidence intervals of the means of the three stations. It can be observed that the 95% CI intervals of the stations 1104 and 1110 do not overlap at all. Station 1106 is in between.**

## Preliminary exploration of the Taxonomic composition.

To explore the differences of the Taxonomic composition a Cluster Analysis was used and a data matrix was prepared to analyze the similarities (see Table 11). A code was created for each station\*year combination and the number of individuals belonging to the species (Arstnr.) was counted. In this way the species composition profile per each sample was used to compare the similarities among the stations.

**Table 11.** Example of the data matrix used as input of the Cluster Analysis. Column header show the “year\_station” codes whereas Artsnr. Is the code for the species.

Artsnr.	1986_04	1987_04	1990_04	....	1992_06	1993_06	1994_06	....	1996_10	1997_10
2010005							2			
3421010										
11000001	6		2	8	8	10	8	6	8	12
18000001							2		0	0
19051535						0				
19106007								2		
19107010	0	0		2	0	4	0	0	4	10
.....										
66405020				0						
66405030	0	48	4	0		0		0		2
66405099							2		2	0
66501010	12	14	22	16	22	2	4	20	4	0
66501099						0		14	0	
66503030		0								
66504030	426	218	56	6	32	416	172	42	228	92
66532010						0				
66532099				0						
66560000			0							
66561010	16	0	0	0	0	0	0	0	2	0
66604010								2		18
75101099			0					0	0	0
81000010						0				

103 spp

Hierarchical Cluster Analysis was used (Afifi and Cark, 1996). As metric of similarity the Euclidean Distance was used. The Ward method was chosen as agglomeration criterion.

As the attached dendrogram shows (Fig. 6) the stations are quite homogeneous in terms of taxonomic composition, since the “ouliers” seem to be confined to some years (e.g. 1994, 1995, 1996 and 1997) and to station 1110.

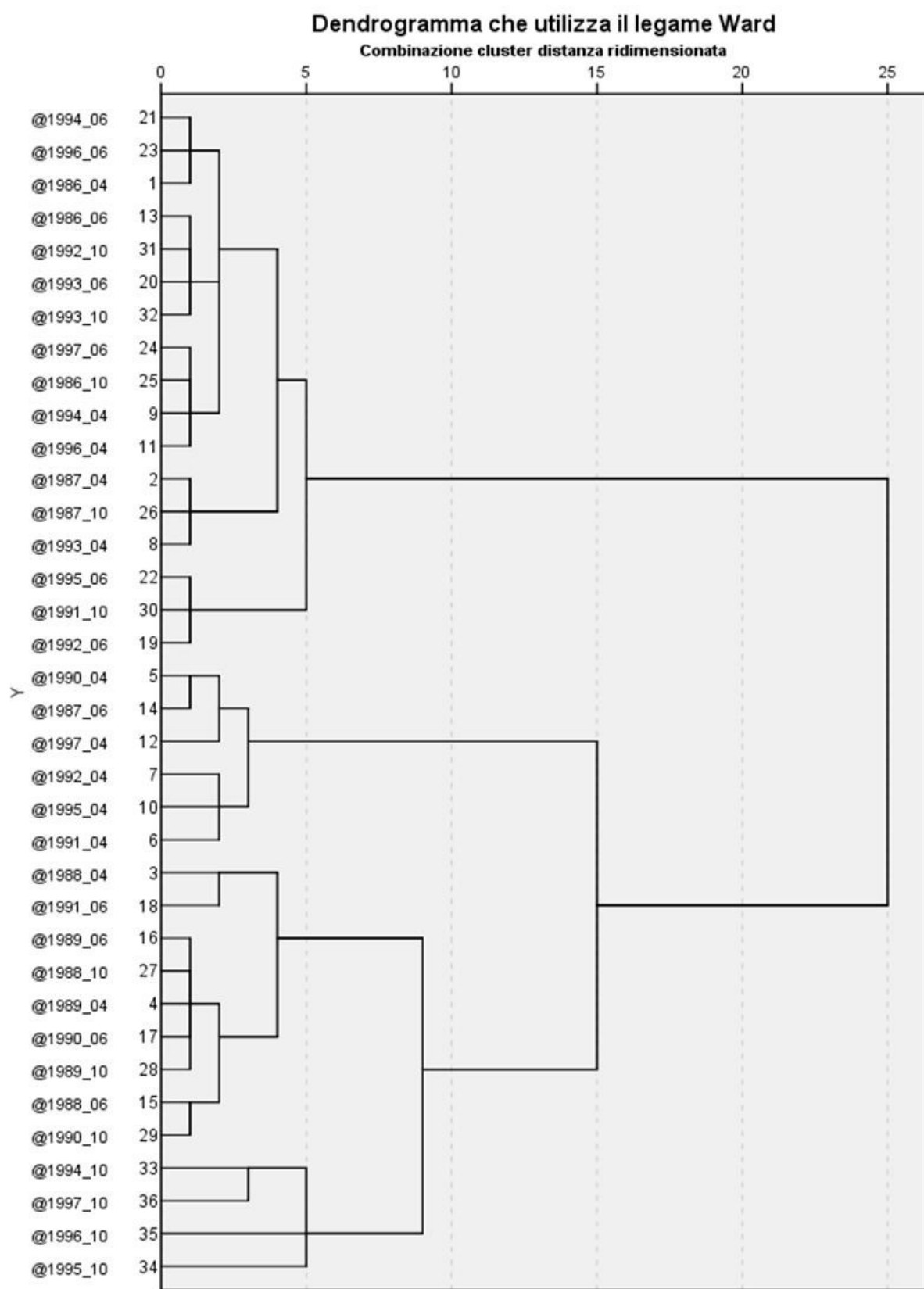


Figure 6. Dendrogram stemming from the Cluster Analysis applied to Table 11.

## Future Work

All the available information about the environmental background in the Hanstholm area will be used to provide a sensitivity map of the area that could be used to predict the impact of the future human activities in the area. This knowledge could also be used as reference baseline in future studies aimed to assess the environmental impact of wave energy installations using a BACI (i.e. Before and After Control Impact) design approach.

If dedicated funds would be available the Hanstholm test site could be used as a pilot area to study environmental impacts and interactions with marine organisms, ranging from small bottom dwelling organisms living in the seabed, organisms involved in biofouling (and therefore of interest to mechanical wear and maintenance) to vertebrates, including fish, seabirds and marine mammals.

Concerning the sea bottom fauna, sediment cores could be collected on seasonal basis in the sites chosen for deploying WEC devices allowing a site-specific quantitative analysis of the macrofauna to assess the percent gain of hard bottom habitat offered by WEC foundations or mooring devices.

Dedicated monitoring campaigns could be designed to assess fish, seabirds and marine mammals abundances in the area.

All the future sampling campaigns should be designed using a BACI approach (e.g. before and after the pilot WEC deployment).

An additional element for the impact assessment would be, after the deployment of WEC devices needing antifouling treatments, the use of biomarker organisms (e.g. Noventa and Pavoni, 2011) to evaluate the contamination due to the antifouling compounds. This analysis would require the collection of additional data for at least a couple of years after WEC deployment and budget for the needed chemical analysis.

## Conclusions

This report presents a preliminary assessment of the environmental background of the DanWEC site and is part of the task 4: “Collection and presentation of basic data on flora and fauna for the DanWEC site at the Port of Hanstholm” of the project No. 834101 “DanWEC Vaekstforum 2011”. The available data on the benthic community collected in the area of the Port of Hanstholm have been analysed. No seasonality effect has been assessed in the available biomass data series whereas a bathymetry effect was detected (i.e. the deepest station has a lower biomass value).

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